

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1-7 (Cancelled).

8. (Currently amended) ~~The method as claimed in claim 7,~~

A method of operating a snapshot copy facility that stores a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time, said method comprising:

the snapshot copy facility receiving a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies; and

the snapshot copy facility responding to the request by returning the difference between the specified older one of the snapshot copies and the specified younger one of the snapshot copies;

wherein the snapshot copy facility has an index for each snapshot copy for indicating changes between said each snapshot copy and a next snapshot copy of the production file system, and the method includes scanning the index for the specified older one of the snapshot copies,

which includes scanning the indices for a sequence of the snapshot copies including the index for the specified older one of the snapshot copies and a respective index for each of a

plurality of snapshot copies of the production file system that are both younger than the specified older one snapshot copies and older than the specified younger one of the snapshot copies, and

wherein the indices for the sequence of the snapshot copies are scanned by a program routine having an outer loop indexing blocks of data in the file system, and an inner loop indexing the snapshot copies in the sequence of the snapshot copies.

9. (Currently amended) ~~The method as claimed in claim 1,~~

A method of operating a snapshot copy facility that stores a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time, said method comprising:

the snapshot copy facility receiving a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies; and

the snapshot copy facility responding to the request by returning the difference between the specified older one of the snapshot copies and the specified younger one of the snapshot copies;

wherein the snapshot copy facility has an index for each snapshot copy for indicating blocks of data that are known to be invalid in said each snapshot copy, and the method includes scanning the index for the specified younger one of the snapshot copies, and when the index indicates that a block is not known to be invalid, then determining whether the block has changed between the specified older one of the snapshot copies and the specified younger one of the snapshot copies.

Claims 10-15 (Cancelled).

16. (Currently amended) ~~The method as claimed in claim 15,~~

A method of operating a snapshot copy facility that stores a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time, the snapshot copy facility having an index for each snapshot copy for indicating blocks of data in the production file system that have changed between said each snapshot copy and a next snapshot copy of the production file system, wherein the method comprises:

scanning the indices for a sequence of the snapshot copies to determine the blocks that have changed between an older one of the snapshot copies and a younger one of the snapshot copies, the sequence of the snapshot copies including the older one of the snapshot copies and each of the snapshot copies that is both younger than the older one of the snapshot copies and older than the younger one of the snapshot copies;

wherein the indices for the sequence of the snapshot copies are scanned by a program routine having an outer loop indexing respective blocks, and an inner loop indexing snapshot copies in the sequence of the snapshot copies; and

wherein the snapshot copy facility has a meta bit map for each snapshot copy for indicating blocks of data that are known to be invalid in said each snapshot copy, and the method includes scanning the meta bit map for the specified younger one of the snapshot copies, and

when the meta bit map is found to indicate that a block is not known to be invalid, then determining whether the block has changed between the specified older one of the snapshot copies and the specified younger one of the snapshot copies by scanning the indices for the sequence of the snapshot copies.

17. (Original) A method of operating a snapshot copy facility that stores a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time, the snapshot copy facility having a first index for each snapshot copy for indicating blocks of data in the production file system that have changed between said each snapshot copy and a next snapshot copy of the production file system and that have a “before image” saved for said each snapshot copy, the snapshot copy facility having a second index for said each snapshot copy for indicating blocks of data that are not in use in said each snapshot copy; said method comprising:

responding to a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies by accessing the second index for the specified younger one of the snapshot copies to determine blocks of data in the production file system that are in use in the specified younger one of the snapshot copies, and for blocks of data in the production file system that are in use in the specified younger one of the snapshot copies, accessing at least one of the first indices for a sequence of the snapshot copies to determine blocks that have changed between an older one of the snapshot copies and a younger one of the snapshot copies, the sequence of the snapshot copies including the older one of the snapshot

copies and each of the snapshot copies that is both younger than the older one of the snapshot copies and older than the younger one of the snapshot copies.

18. (Original) The method as claimed in claim 17, which also includes accessing at least one of the second indices for the snapshot copies in the sequence of the snapshot copies and finding that at least one of the blocks is not in use in at least one of the snapshot copies in the sequence of the snapshot copies to determine that said at least one of the blocks has changed between the older one of the snapshot copies and the younger one of the snapshot copies not changed.

Claims 19-32. (Cancelled).

33. (Currently amended) ~~The snapshot copy facility as claimed in claim 32;~~
A snapshot copy facility comprising:
storage for storing a plurality of snapshot copies of a production file system, each of the
snapshot copies being a prior state of the production file system at a respective point in time; and
at least one processor programmed for receiving a request for the difference between a
specified older one of the snapshot copies and a specified younger one of the snapshot copies;
and for responding to the request by returning the difference between the specified older one of
the snapshot copies and the specified younger one of the snapshot copies;

wherein the snapshot copy facility has an index for each snapshot copy for indicating changes between said each snapshot copy and a next snapshot copy of the production file system, and said at least one processor is programmed for scanning the index for the specified older one of the snapshot copies,

wherein said at least one processor is programmed for scanning the indices for a sequence of the snapshot copies including the index for the specified older one of the snapshot copies and a respective index for each of a plurality of snapshot copies of the production file system that are both younger than the specified older one snapshot copies and older than the specified younger one of the snapshot copies, and

wherein said at least one processor is programmed for scanning the indices for the sequence of the snapshot copies by a program routine having an outer loop indexing the blocks, and an inner loop indexing the snapshot copies in the sequence of the snapshot copies.

34. (Currently amended) ~~The snapshot copy facility as claimed in claim 26;~~

A snapshot copy facility comprising:

storage for storing a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time; and

at least one processor programmed for receiving a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies; and for responding to the request by returning the difference between the specified older one of the snapshot copies and the specified younger one of the snapshot copies;

wherein the snapshot copy facility has an index for each snapshot copy for indicating blocks of data that are known to be invalid in said each snapshot copy, and said at least one processor is programmed for scanning the index for the specified younger one of the snapshot copies, and when the index indicates that a block is not known to be invalid, then determining whether the block has changed between the specified older one of the snapshot copies and the specified younger one of the snapshot copies.

Claims 35-40 (Cancelled).

41. (Currently amended) ~~The snapshot copy facility as claimed in claim 35,~~

A snapshot copy facility comprising:

storage for storing a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time;

an index for each snapshot copy for indicating blocks of data in the production file system that have changed between said each snapshot copy and a next snapshot copy of the production file system, and

at least one processor programmed for scanning the indices for a sequence of the snapshot copies to determine the blocks that have changed between an older one of the snapshot copies and a younger one of the snapshot copies, the sequence of the snapshot copies including the older one of the snapshot copies and each of the snapshot copies that is both younger than the older one of the snapshot copies and older than the younger one of the snapshot copies,

which includes a meta bit map for each snapshot copy for indicating blocks of data that are known to be invalid in said each snapshot copy, and wherein said at least one processor is programmed for scanning the meta bit map for the specified younger one of the snapshot copies, and when the meta bit map is found to indicate that a block is not known to be invalid, then determining whether the block has changed between the specified older one of the snapshot copies and the specified younger one of the snapshot copies by scanning the indices for the sequence of the snapshot copies.

42. (Original) A snapshot copy facility comprising:

storage for storing a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time;

a first index for each snapshot copy for indicating blocks of data in the production file system that have changed between said each snapshot copy and a next snapshot copy of the production file system and that have a "before image" for said each snapshot copy stored in the storage,

a second index for each snapshot copy for indicating blocks of data that are not in use in said each snapshot copy, and

at least one processor programmed for responding to a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies by accessing the second index for the specified younger one of the snapshot copies to determine blocks of data in the production file system that are in use in the specified younger one of the

snapshot copies, and for blocks of data in the production file system that are in use in the specified younger one of the snapshot copies, accessing at least one of the first indices for a sequence of the snapshot copies to determine blocks that have changed between an older one of the snapshot copies and a younger one of the snapshot copies, the sequence of the snapshot copies including the older one of the snapshot copies and each of the snapshot copies that is both younger than the older one of the snapshot copies and older than the younger one of the snapshot copies.

43. (Original) The snapshot copy facility as claimed in claim 42, wherein said at least one processor is also programmed for accessing at least one of the second indices for the snapshot copies in the sequence of the snapshot copies and finding that at least one of the blocks is not in use in at least one of the snapshot copies in the sequence of the snapshot copies to determine that said at least one of the blocks has changed between the older one of the snapshot copies and the younger one of the snapshot copies not changed.

Claims 44-53. (Cancelled).

54. (Currently amended) ~~The program storage device as claimed in claim 53,~~
A program storage device containing a program for a snapshot copy facility, the snapshot copy facility storing a plurality of snapshot copies of a production file system, each of the

snapshot copies being a prior state of the production file system at a respective point in time, wherein the program is executable for responding to a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies by returning the difference between the specified older one of the snapshot copies and the specified younger one of the snapshot copies,

wherein the snapshot copy facility has an index for each snapshot copy for indicating changes between said each snapshot copy and a next snapshot copy of the production file system, and the program is executable for scanning the index for the specified older one of the snapshot copies,

wherein the program is executable for scanning the indices for a sequence of the snapshot copies including the index for the specified older one of the snapshot copies and a respective index for each of a plurality of snapshot copies of the production file system that are both younger than the specified older one snapshot copies and older than the specified younger one of the snapshot copies,

wherein the program is executable for scanning the indices for a sequence of the snapshot copies including the index for the specified older one of the snapshot copies and a respective index for each of a plurality of snapshot copies of the production file system that are both younger than the specified older one snapshot copies and older than the specified younger one of the snapshot copies, and

wherein the program is executable for scanning the indices for the sequence of the snapshot copies by a program routine having an outer loop indexing the blocks, and an inner loop indexing the snapshot copies in the sequence of the snapshot copies.

Claims 55-58 (Cancelled).

59. (Currently amended) ~~The program storage device as claimed in claim 55,~~

A program storage device containing a program for a snapshot copy facility, the snapshot copy facility having a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time, and an index for each snapshot copy for indicating blocks of data in the production file system that have changed between said each snapshot copy and a next snapshot copy of the production file system, wherein the program is executable for scanning the indices for a sequence of the snapshot copies to determine the blocks that have changed between an older one of the snapshot copies and a younger one of the snapshot copies, the sequence of the snapshot copies including the older one of the snapshot copies and each of the snapshot copies that is both younger than the older one of the snapshot copies and older than the younger one of the snapshot copies,

wherein the snapshot copy facility has a meta bit map for each snapshot copy for indicating blocks of data that are known to be invalid in said each snapshot copy, and wherein the program storage device is executable for scanning the meta bit map for the specified younger one of the snapshot copies, and when the meta bit map is found to indicate that a block is not

known to be invalid, then determining whether the block has changed between the specified older one of the snapshot copies and the specified younger one of the snapshot copies by scanning the indices for the sequence of the snapshot copies.

60. (Original) A program storage device containing a program for a snapshot copy facility, the snapshot copy facility having a plurality of snapshot copies of a production file system, each of the snapshot copies being a prior state of the production file system at a respective point in time, a first index for each snapshot copy for indicating blocks of data in the production file system that have changed between said each snapshot copy and a next snapshot copy of the production file system and that have a "before image" for said each snapshot copy stored in the snapshot copy facility, and a second index for each snapshot copy for indicating blocks of data that are not in use in said each snapshot copy, wherein the program is executable for responding to a request for the difference between a specified older one of the snapshot copies and a specified younger one of the snapshot copies by accessing the second index for the specified younger one of the snapshot copies to determine blocks of data in the production file system that are in use in the specified younger one of the snapshot copies, and for blocks of data in the production file system that are in use in the specified younger one of the snapshot copies, accessing at least one of the first indices for a sequence of the snapshot copies to determine blocks that have changed between an older one of the snapshot copies and a younger one of the snapshot copies, the sequence of the snapshot copies including the older one of the snapshot

copies and each of the snapshot copies that is both younger than the older one of the snapshot copies and older than the younger one of the snapshot copies.

61. (Original) The program storage device as claimed in claim 60, wherein the program is executable for accessing at least one of the second indices for the snapshot copies in the sequence of the snapshot copies and finding that at least one of the blocks is not in use in at least one of the snapshot copies in the sequence of the snapshot copies to determine that said at least one of the blocks has changed between the older one of the snapshot copies and the younger one of the snapshot copies not changed.

Claims 62-66 (Cancelled).